ROYAL ASTRONOMICAL SOCIETY.

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G. B. AIRY, Esq., Astronomer Royal, President, in the Chair.

Mons. V. Fasel, of Stow, near Aylesbury;
Commander W. T. Bate, R.N., South Sea, Portsmouth;
Wm. Brooke, Esq., Gray Friars' Priory, Norwich;
Edward Bury, Esq., 14 Moorgate Street; and
Henry Barrow, Esq., 26 Oxendon Street;
were balloted for and duly elected Fellows of the Society.

The annual 4to. half-volume, containing the more extensive memoirs, for the year 1847–48, is just completed, and will be ready for delivery in a few days. The price is 6*s.* to Fellows of the Society and 12*s.* to the Public. The annual 8vo. half-volume, which contains the observations, shorter memoirs, abstracts, &c. is *given* with the 4to. half-volume. The two are complementary to each other, and scarcely contain any thing in common, except the Annual Report.

At the conclusion of the Annual Report, mention is made of an application by the Council to Viscount Palmerston, requesting his lordship's good offices in favour of our venerable and respected associate, Professor Schumacher. We are happy to say that his lordship not only received the application with the utmost courtesy, but has brought the matter before the Danish Government with great earnestness, and we trust with the best effect. It is understood that similar representations have been made by almost all the civilised states in Europe, a remarkable tribute to the individual merits of Professor Schumacher, and honourable to all the parties concerned. The occasion is new, and the unanimous and spontaneous expression of feeling in different countries is most creditable to the character of the science and to its cultivators.

We subjoin a letter addressed to the Royal Astronomical Society, by the President and Mathematical Section of the Imperial and Royal Institute of Sciences, Letters, and Arts, in the Venetian Provinces :—

* For economical reasons, a portion of the abstracts is reserved for the next *Notice*.

"*To the Royal Astronomical Society of London, from the Members of the Mathematical Section of the Imperial and Royal Institute of Sciences, Letters, and Arts, in the Venetian Provinces.*

"Repeated communications from some of our members to the mathematical class of the Institute, have excited in us the painful apprehension that the recent disputes between the German Diet and the Kingdom of Denmark, with respect to the duchies of Schleswig-Holstein, may endanger the actual centre of astronomical relations, the celebrated establishment and observatory of Altona, by suspending the valuable labours of the Nestor of living astronomers, the meritorious and illustrious Councillor Schumacher,—an event which would be injurious in the highest degree to astronomical science and to all its ardent cultivators.

"The Royal Astronomical Society of London, to which Astronomy and Navigation are so deeply indebted, can measure better than any other scientific body the irreparable loss which theoretical and practical Astronomy would suffer, should any material change be made in that admirable establishment. The Royal Astronomical Society well knows the indefatigable activity of Professor Schumacher, appreciates the felicity of his geographical position, in one of the greatest centres of communication between civilised nations, and estimates, at its due value, the extent and refinement of the plan of the *Astronomische Nachrichten*, in which for nearly thirty years the learned editor has published with the greatest promptness every discovery, and every new step towards perfecting Astronomy, Geography, and Mathematics.

"The Observatory of Altona, owing to the intelligence and activity of its director and chief, and to its favourable situation, must be regarded as an European institution; and all those who are friendly to the progress of science should interest themselves in its preservation.

"As the Government of England will, doubtless, have a large share in settling the disputes which do or may compromise the fortune of so important an establishment, we apply to your illustrious Society, in the confident hope that, in our name as well as in your own, you will interpose your good offices for the preservation of the actual state of the Observatory of Altona, and of its incomparable director.

"This prayer of Science will doubtless find favour from the enlightened Government of your powerful and civilised nation,—a nation by which, in all time, Astronomy, Geography, and Navigation, have been vigorously protected and promoted.

"Ludovico Menin, President of the Institute, and Professor of History in the University of Padua.

"Serafino Raffaelle Minich, Professor.

"Carlo Conti, Professor of Mechanics.

"Domenico Turazza, Professor of Geodesy and Hydrometry.

"Giovanni Santini, Professor of Astronomy.

"Giusto Bellavitis, Professor of Descriptive Geometry."

IRIS.

Observations.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1849.	Greenwich M.T.	R.A.	N.P.D.	Comp^{d}—Observ^{d}. R.A.	N.P.D.	Star.
	h m s	h m s	° ′ ″	s	″	
Jan. 22	13 18 59·5	10 18 13·80	87 47 43·8	...	...	*a*
30	12 0 57·0	11 40·00	33 19·9	+0·11	+2·6	*b*
31	10 54 21·7	10 47·72	30 45·3	+0·14	2·9	*b*
Feb. 8	10 47 36·1	10 3 0·88	87 3 26·9	−0·25	7·1	*c*
12	11 44 20·9	9 58 52·66	86 46 11·1	0·19	5·3	*d*
13	10 47 28·2	57 53·60	41 47·6	0·55	5·0	*d*
17	11 49 43·6	53 44·32	22 16·6	0·73	7·3	*e*
19	9 19 57·2	51 48·90	86 12 42·0	0·83	7·8	*e*
26	9 35 43·6	45 0·20	85 35 50·7	1·00	4·2	*f*
28	9 48 48·6	43 10·92	25 3·8	1·17	4·7	*f*
Mar. 1	9 54 31·0	42 18·02	19 41·6	1·45	4·0	*f*
2	10 40 25·3	41 24·45	14 9·7	1·14	4·8	*f*
3	11 29 22·0	40 32·44	85 8 41·3	1·31	2·7	*f*
5	11 12 27·4	9 38 55·94	84 58 9·7	−1·37	+4·1	*f*

a	3458, 3684	B.A.C.	*d*	3412, 3483 B.A.C.
b	3483, 3570	—	*e*	3374, 3449 —
c	3412, 3532	—	*f*	3295, 3412 —

"The places of the stars of comparison are taken from the catalogue cited. The observed places are corrected for refraction and parallax. The computed places are deduced from the *corrected* ephemeris of MM. Pogson and Hind, which is printed in the present *Monthly Notice*.

"The N.P.D. are all from the circle readings. The method of observing is to select two stars from the B.A.C.; in general, one preceding and the other following the planet; one north and the other south of the planet. The instrument is firmly clamped in R.A., and the transits of the two stars and planet observed, each over five wires, the bisection with the horizontal wire is made at the time of transit by means of the slow motion screw attached to the declination circle. Immediately after each transit the two micrometer microscopes of the declination circle are read. The instrument is then unclamped in R.A., and the observations repeated, sometimes with the instrument in the same position as regards the declination circle; at other times the declination-axis is reversed for the second series, when the microscopes can be conveniently got at after so doing."

DURHAM. Fraunhofer Equatoreal. (Professor Chevallier and Rev. R. A. Thompson.)

1849.	Greenwich M.T.	R.A.	N.P.D.	Comp^{d}—Obs^{d}. R.A.	N.P.D.	No. Comp.	Star.
	h m s	h m s	° ′ ″	s	″		
Feb. 7	12 27 34·7	10 3 56·69	87 7 8·5	+0·36	+6·6	4	*a*
8	9 57 14·6	10 3 2·95	87 3 36·3	−0·21	6·3	8	*a*
13	9 56 21·3	9 57 55·72	86 41 57·6	0·48	4·8	6	*b*
19	11 28 37·6	51 42·96	12 18·6	0·30	3·8	6	*c*
20	8 28 30·3	50 50·37	7 49·2	0·48	2·4	6	*c*
21	11 30 40·7	49 43·07	86 1 57·5	0·47	3·2	4	*c*
28	9 30 50·8	43 11·74	85 25 5·7	1·44	6·8	3	*d*
Mar. 3	9 3 42·0	9 40 37·04	85 9 8·4	−0·99	+7·8	6	*e*

The computed place is taken from the *corrected* ephemeris published in the present *Monthly Notice*.

The following are the assumed *apparent* places of the stars, deduced from one observation of each with the transit circle, except the last star, which has been brought up from the Edinburgh Observations for 1837.

		R.A.	N.P.D.
		h m s	° ′ ″
a = H.C. 19782	Feb. 7	10 1 38·03	86 53 38·4
b = H.C. 19722	13	9 58 20·90	86 50 29·1
c = B.A.C. 3412	19	9 51 54·21	85 53 59·8
d = H.C. 19268	28	9 41 50·61	85 12 23·6
e = B.A.C. 3359	Mar. 3	9 42 39·87	84 57 17·7

HAVERHILL. Equatoreal. (W. W. Boreham, Esq.)

1849.	Greenwich M.T. h m s	R.A. h m s	N.P.D. ° ′ ″	Obs.	Star of Comp.	
Jan. 17	10 10 38	10 21 40·35	87 50 24·6	4	Weisse, x.	392
22	10 10 2	18 19·48	47 37·5	6	—	294
26	9 48 37	15 12·59	42 15·8	5	—	247
Feb. 2	10 51 14	8 55·23	25 1·6	1	—	107
8	10 1 14	3 3·34	87 3 26·9	4	—	6
10	9 52 9	1 3·75	86 55 33·9	4	—	6
11	9 45 59	10 0 0·79	51 5·5	6	—	6
12	10 1 44	9 58 56·72	46 11·9	5	H.C.	19722
13	10 2 57	57 55·56	41 38·3	5	—	—
15	10 39 41	55 50·39	32 43·1	10	B.A.C.	3436
16	10 2 4	54 50·26	27 55·6	5	—	—
17	10 47 26	53 47·19	22 44·6	6	Weisse, ix.	1149
19	10 4 9	51 46·97	12 53·9	8	B.A.C.	3412
20	10 44 12	9 50 45·18	86 7 30·5	5	—	—

Corrected for parallax and refraction.

HAMBURG. Meridian Circle. (M. C. Rümker.)

1849.	Hamburg M.T. h m s	R.A. ° ′ ″	Dec. ° ′ ″
Feb. 1	13 21 24·5	152 26 57·4	+2 32 13·7
2	13 16 32·1	152 12 47·6	+2 35 16·9

Ephemeris of Iris (by MM. Hind and Pogson) from Mr. Pogson's Elements, p. 42.

For Greenwich Mean Midnight.

1849.	Appt R.A. h m s	Appt N.P.D. ° ′ ″	1849.	Appt R.A. h m s	Appt N.P.D. ° ′ ″
Jan. 24	10 16 45·38	87 45 29·4	Jan. 30	10 11 40·15	87 33 22·6
25	15 57·60	43 56·2	31	10 45·34	30 42·7
26	15 8·51	42 12·3	Feb. 1	9 49·56	27 52·1
27	14 18·17	40 16·6	2	8 52·85	24 51·4
28	13 26·63	38 9·7	3	7 55·32	21 40·5
29	10 12 33·94	87 35 51·7	4	10 6 57·01	87 18 19·6

1849.	Appt R.A. h m s	Appt N.P.D. ° ′ ″
Feb. 5	10 5 58·00	87 14 48·7
6	4 58·39	11 8·7
7	3 58·22	7 19·6
8	2 57·56	87 3 21·9
9	1 56·54	86 59 16·0
10	10 0 55·18	55 2·5
11	9 59 53·59	50 41·7
12	58 51·81	46 13·5
13	57 49·93	41 38·6
14	56 48·02	36 57·5
15	55 46·21	32 10·7
16	54 44·56	27 18·8
17	53 43·15	22 21·8
18	52 42·05	17 20·4
19	51 41·34	12 15·1
20	50 41·08	7 6·0
21	49 41·39	86 1 54·3
22	48 42·29	85 56 39·8
23	47 43·90	51 22·8
24	46 46·29	46 3·9
25	45 49·52	40 43·8
26	44 53·65	35 22·7
27	43 58·75	30 1·1
28	43 4·88	24 39·2
Mar. 1	42 12·10	19 17·6
2	41 20·49	13 56·8
3	40 30·07	8 37·2
4	39 40·90	85 3 19·3
5	38 53·03	84 58 3·4
6	38 6·51	52 49·6
7	37 21·39	47 38·5
8	36 37·70	42 30·3
9	35 55·47	37 25·5
10	35 14·75	32 24·3
11	34 35·52	27 26·8
12	33 57·85	22 33·4
13	33 21·76	17 44·3
14	32 47·26	12 59·8
15	32 14·37	8 20·1
16	31 43·13	84 3 45·6
17	31 13·54	83 59 16·2
18	30 45·63	54 52·2
19	30 19·43	50 34·2
20	9 29 54·94	83 46 22·2

1849.	Appt R.A. h m s	Appt N.P.D. ° ′ ″
Mar. 21	9 29 32·17	83 42 16·4
22	29 11·11	38 16·9
23	28 51·80	34 23·8
24	28 34·22	30 37·5
25	28 18·38	26 57·9
26	28 4·26	23 25·1
27	27 51·89	19 59·4
28	27 41·25	16 40·7
29	27 32·33	13 29·4
30	27 25·12	10 25·2
31	27 19·63	7 28·6
April 1	27 15·81	4 39·2
2	27 13·70	83 1 57·6
3	27 13·26	82 59 23·2
4	27 14·43	56 56·4
5	27 17·24	54 37·2
6	27 21·65	52 25·6
7	27 27·67	50 21·5
8	27 35·25	48 25·1
9	27 44·39	46 36·5
10	27 55·06	44 55·3
11	28 7·26	43 21·8
12	28 20·96	41 55·8
13	28 36·14	40 37·5
14	28 52·80	39 26·7
15	29 10·89	38 23·6
16	29 30·41	37 28·1
17	29 51·34	36 40·1
18	30 13·64	35 59·4
19	30 37·31	35 26·3
20	31 2·35	35 0·9
21	31 28·72	34 43·1
22	31 56·40	34 32·7
23	32 25·38	34 29·7
24	32 55·62	34 34·2
25	33 27·11	34 46·2
26	33 59·84	35 5·5
27	34 33·78	35 32·0
28	35 8·89	36 5·8
29	35 45·11	36 46·6
30	36 22·48	37 34·7
May 1	37 0·98	38 29·9
2	37 40·57	39 32·0
3	9 38 21·23	82 40 41·2

1849.	Appt R.A. h m s	Appt N.P.D. ° ′ ″	1849.	Appt R.A. h m s	Appt N.P.D. ° ′ ″
May 4	9 39 2·91	82 41 57·3	May 11	9 44 21·87	82 53 56·7
5	39 45·60	43 20·2	12	45 11·15	56 5·8
6	40 29·29	44 49·7	13	46 1·29	82 58 21·1
7	41 13·91	46 25·9	14	46 52·28	83 0 42·9
8	41 59·47	48 8·6	15	47 44·14	3 10·7
9	42 46·02	49 58·1	16	9 48 36·82	83 5 45·0
10	9 43 33·50	82 51 54·2			

The R.A. is reckoned from the true equinox, and the ephemeris is corrected for aberration, so that the computed places require no further correction.*

Horizontal Parallax.

1848.	″	1848.	″	1848.	″
Jan. 24	5·82	March 5	5·65	April 14	4·41
28	5·88	9	5·54	18	4·29
Feb. 1	5·93	13	5·43	22	4·17
5	5·96	17	5·31	26	4·06
9	5·97	21	5·18	30	3·95
13	5·96	25	5·05	May 4	3·86
17	5·93	29	4·92	8	3·74
21	5·88	April 2	4·79	12	3·63
25	5·82	6	4·66	16	3·52
March 1	5·74	10	4·53		

HEBE.

DURHAM. Fraunhofer Equatoreal. (Professor Chevallier and Rev. R. A. Thompson.)

1848.	Greenwich M.T. h m s	R.A. h m s		N.P.D. ° ′ ″		No. of Obs.
Dec. 15	12 36 34·1	6 9 25·19	0·00 P.	86 49 9·2	−·78 P.	Merid.
27	10 48 7·2	5 56 57·00	−·008	85 33 22·1	−·77	11
1849.						
Jan. 16	10 47 5·1	5 40 30·82	+·008	82 29 22·8	−·73	2
17	8 4 24·4	40 1·39	−·018	82 20 18·2	−·74	12
26	10 4 15·6	36 25·63	+·008	80 46 15·7	−·71	4
	11 11 17·4	24·64	+·018	45 45·7	−·72	6
30	8 15 3·7	35 42·63	−·008	80 5 24·3	−·71	6
31	9 33 12·3	35 36·33	+·007	79 54 32·7	−·71	5
Feb. 8	7 55 29·3	35 55·98	−·005	78 34 16·2	−·69	2
	8 19 8·6	56·27	−·002	9·4	−·68	6
13	8 22 37·3	37 8·62	+·003	77 45 16·5	−·67	8
22	8 26 32·5	41 9·92	+·008	76 22 9·1	−·60	5
26	8 9 43·4	43 37·00	+·008	75 47 27·7	−·65	6
28	8 27 35·5	5 45 0·59	+·011 P.	75 30 29·9	−·65 P.	6

* A slight error was committed in the former ephemerides, which has been corrected in this. The interpolation is made from places calculated for every eight days, and is tolerably satisfactory.

Corrected for refraction, P is the horizontal parallax in arc, to be applied with the sign and coefficient to the observed places.

Feb. 22. Clock scarcely audible.

The following are the assumed *apparent* places of the stars of comparison deduced from observations with the transit circle, or as otherwise described:—

		R.A. h m s	N.P.D. ° ′ ″	Obs.
Dec. 27	B.A.C. 1945	5 57, 0·77	85 50 36·1	1
Jan. 16	*α* Orionis from the Nautical Almanac.			
17	H.C. 10991	5 40 21·09	82 30 30·6	1
26	B.A.C. 1826	5 38 35·87	80 32 29·0	2
30, 31	— 1851	5 41 44·59	80 10 48·9	1
Feb. 8	*a*	5 36 16·43	78 39 53·6	
8	H.C. 10810	5 35 27·15	78 40 16·8	2
13	H.C. 10892	5 37 56·31	77 32 45·9	1
22	B.A.C. 1834	5 39 9·81	76 9 49·9	
26	H.C. 11092	5 43 48·25	75 52 28·3	2
28	B.A.C. 1853	5 42 13·13	75 36 26·9	

The place of *a* depends on two comparisons with H.C. 10810, that of B.A.C. 1853 on four comparisons with B.A.C. 1852, which has been once observed. The place of B.A.C. 1834 depends on the Edinburgh Observations, 1837.

HAMBURG. Meridian Circle. (M. C. Rümker.)

1849.	Hamburg M.T. h m s	R.A. ° ′ ″	N.P.D. ° ′ ″
Jan. 23	9 25 4·5		81 18 0·6
27	9 8 13·3	84 3 4·5	80 36 33·1
Feb. 1	8 47 53·7	83 53 0·4	79 45 2·5

FLORA.

HAMBURG. Equatoreal. (M. C. Rümker.)

1848.	Hamburg M.T. h m s	R.A. ° ′ ″	N.P.D. ° ′ ″
Dec. 24	17 14 36·1	207 11 12·7	95 37 14·2
28	17 0 19·0	208 28 56·0	95 58 51·5
29	17 45 7·5	208 48 48·8	96 4 21·7
1849.			
Jan. 2	17 35 10·2	210 3 40·7	23 35·9
3	16 55 51·0	210 21 17·4	96 28 1·5
31	16 50 2·1	217 34 52·5	97 53 23·2
Feb. 1	17 35 39·4	217 47 23·8	54 48·4
2	16 12 29·0	217 58 16·0	97 55 54·0

NEPTUNE.

MARKREE. In the Meridian. (E. J. Cooper, Esq. and Mr. A. Graham.)

1848.	Greenwich M.T. h m s	R.A. h m s	N.P.D. ° ′ ″
July 28	14 22 51·3	22 16 30·64	101 25 34·0
Aug. 17	13 2 15·8	14 33·04	36 55·7
22	12 42 5·4	14 2·02	39 53·8
29	12 13 50·6	13 18·50	44 3·2
Sept. 22	10 37 8·8	10 58·10	101 57 9·5
29	10 9 2·4	10 22·89	102 0 24·0
Oct. 6	9 41 0·5	9 52·24	3 12·0
10	25 1·2	9 36·53	4 36·6
13	13 2·7	9 25·73	5 34·9
14	9 3·5	9 22·46	5 53·0
16	9 1 6·0	9 15·95	6 28·2
17	8 57 31·9	9 12·88	6 44·1
18	53 7·7	9 10·17	7 0·1
19	49 9·1	9 7·51	7 17·0
24	29 32·3	8 54·80	8 20·3
25	25 19·1	8 52·92	8 29·9
27	17 23·4	8 48·99	8 50·8
31	8 1 33·4	8 42·64	9 21·0
Nov. 1	7 57 36·2	8 41·36	9 27·5
2	53 39·2	8 40·24	9 34·4
3	49 42·3	8 39·21	9 38·3
7	33 55·8	8 36·39	9 49·5
9	26 3·3	8 35·93	9 51·4
15	7 2 29·1	8 36·98	9 40·9
20	6 42 54·4	8 41·94	9 10·5
22	35 5·1	8 44·53	8 53·5
24	6 27 16·8	8 48·07	8 32·5
Dec. 8	5 32 49·7	9 25·60	4 54·8
13	5 13 31·3	22 9 44·99	102 3 4·9

Oct. 17. The planet exceedingly faint; got but two wires; cannot depend on the bisection.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1849.	Greenwich M.T. h m s	R.A. h m s	N.P.D. ° ′ ″	Star of Comp.
Jan. 17	6 36 43·7	22 13 15·95	101 43 15·3	7740, 7821 B.A.C.
26	5 58 15·9	22 14 25·94	101 36 43·8	— —

Corrected for refraction and parallax.

"The N.P.D. are from the readings of the circle.
"The places of the comparison stars are taken from the catalogue cited."

DURHAM. Equatoreal and Mer. Circle. (Prof. Chevallier and Rev. M. Thompson.)

1848.	Greenwich M.T. h m s	R.A. h m s	Comp^{d}—Obs^{d}. s	N.P.D. ° ′ ″	Comp^{d}—Obs^{d}. ″	Obs.
Sept. 18	10 25 47·0	22 11 19·61	+1·59			Mer.
	11 1 58·2	19·36	1·70	101 55 9·0	−7·5	1
19	8 3 37·7	11 14·94	1·31	101 55 35·8	7·6	4
	10 21 45·5	14·08	1·65	40·6	9·5	Mer.
Oct. 9	9 1 34·0	9 40·38	1·55	102 4 14·3	7·5	—
24	8 1 50·0	8 54·93	1·65	8 20·8	11·5	—
25	7 57 51·9	8 52·72	1·75	8 28·9	8·5	—
Nov. 7	7 6 28·7	8 36·19	1·98	9 47·6	6·5	—
Dec. 4	5 20 54·5	9 12·27	1·78	6 10·9	9·1	—
5	6 30 15·9	9 15·53	1·80	102 5 50·2	7·5	6
22	6 46 25·1	10 27·27	2·18	101 58 59·9	7·6	6
28	5 50 33·6	11 0·90	1·55	55 52·5	6·5	4
1849.						
Jan. 15	6 13 48·3	13 1·00	1·42	44 40·1	8·3	2
17	6 14 2·9	22 13 15·12	+2·21	101 43 14·0	−5·8	6

Corrected for parallax and refraction, and compared with Mr. Adams's *Ephemeris*.

The second observation on Sept. 18, and the first observation on Sept. 19, were made with the Fraunhofer Equatoreal, and the star of comparison was B.A.C. 7740. On Dec. 5th and the following days, *Neptune* was compared in like manner with B.A.C. 7821. The other observations were made in the meridian.

The positions of the stars have been assumed from the following mean places, for Jan. 1, 1848, as determined by meridian observations :—

	R.A. h m s	N.P.D. ° ′ ″	No. of Obs.
B.A.C. 7740	22 4 10·29	101 48 46·8	4
7821	22 18 36·84	101 59 54·0	5

LASSELL'S SATELLITE OF NEPTUNE.

LIVERPOOL. (Mr. Lassell.)

Greenwich M.T.	Position. °	Obs.	Distance. ″	Obs.
1848, Aug. 19·51	220	estd.	18·01	5
28·47	38·5	3		
Sept. 12·46	221·3	1		
18·47	223·8	4	16·21	4

CAMBRIDGE, U.S. (Professor W. C. Bond.)

1847.	Cambridge M.T. h m	Position. °	C^{d}—O^{d}. °	Distance. ″	C^{d}—O^{d}. ″	Obs.
Oct. 25	7 45	230	+0·3	15·4	−0·3	3
27	7 30	29	+5·4	13·6	+0·3	7
28	7 35	47	+3·2	14·9	−0·4	9
30	7 0	218	−3·7	15·6	−1·4	3
Nov. 2	7 15	34	+1·8	14·0	+0·8	5

1847.	Cambridge M.T. h. m	Position. °	C^d—O^d. °	Distance. ″	C^d—O^d. ″	Obs.
Nov. 3	7 0	51	+0·6	12·6	+1·1	4
26	7 26	45	—1·2	15·9	+0·2	15
1848.						
July 3	16 15	219	+4·1	16·2	+0·4	14
11	15 15	24	+3·5	12·0	—0·4	2
21	15 0	234	—5·8	16·2	—0·5	5
Aug. 31	10 30	225	—1·3	16·6	+0·2	14
Oct. 11	7 50	220	+0·6	16·4	—0·1	6
12	10 10	245	—2·2	9·6	—0·1	3
20	9 54	41	+3·3	15·8	+0·5	11
23	7 50	221	+2·6	16·3	+0·1	10
28	8 0	212	—3·7	11·2	+0·1	3
Nov. 1	7 0	221	—2·8	16·5	—0·7	4

The column headed C^d—O^d contains the differences between the Observed places and those Computed from the following orbit:—

Period	5^d·8752	
Inclination	30°	
Ascending Node	300°	if the motion is *direct*.

Passage of Ascending Node, Oct. 30·37, 1848, Greenwich M.T.

Mean Distance 16″·3

The mass of *Neptune* corresponding to this distance is $= \frac{1}{19400}$.

EIGHTH SATELLITE OF SATURN (*Hyperion*).

CAMBRIDGE, U.S. Equatoreal. (Professor W. C. Bond.)

Camb. M.S.T.	Distance from Saturn's Centre.	Camb. M.S.T.	Distance from Saturn's Centre.
d	″	d	″
1848. Sept. 19·56	+256	Oct. 21·42	—206
21·52	+220	23·42	—178
22·44	+192	27·34	+ 88
23·38	+145	28·31	+136
28·38	—156	Nov. 1·31	+248
Oct. 13·32	+202	2·30	+198
14·29	+152	3·31	+228
15·40	+ 92	1849. Jan. 12·29	—132
20·31	—187		

In the above table + indicates that the Satellite *follows Saturn*; and — that it *precedes* the Planet.

The following is an approximation to the orbit of *Hyperion*, computed by G. P. Bond:—

Period	21·18 days
Mean Dist. ...	214″
Eccentricity	0·115
Epoch	97° Jan. 1, 1849
Perisaturnium	295°

The plane of the orbit coincides nearly with that of the ring. It probably undergoes very considerable perturbations from the influence of *Titan*.

LIVERPOOL. 20-foot Reflector. (Mr. Lassell.)

1848.	Sept.	21·55	Hyperion	East of Saturn	234″
		22·41	,,	,, ,,	207
	Oct.	20·35	,,	West ,,	178
		22·44	,,	,, ,,	203
	Nov.	14·36	,,	,, ,,	133
		24·45	,,	,, ,,	202·8

SATELLITES OF URANUS.

LIVERPOOL. (Mr. Lassell.)

			Satellite.	Position.	Obs.	Distance.	Obs.
1848.	Sept.	16·60	II.	200°	est.		
			IV.	195	,,		
			?	340	,,	two diam. of planet.	
		18·53	II.	145·4	3	31″·7	2
			IV.	158·2	2	45·2	2
			?	305	est.	10	est.
	Oct.	27·48	II.	332·9	4	31·05	4
			IV.	178·4	4	41·2	3
	Nov.	4·38	II.	351·4	3	30	est.
			IV.	340	est.	44·5	2
		30·46	II.	351	est.	32·15	3
			IV.	353·3	2	43·43	3
	Dec.	1·47	II.	324·4	2	25·52	2
			IV.	336	2	40·26	3

ECLIPSES OF JUPITER'S SATELLITES.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1849.			Imm. h m s	Emer. h m s		Power.
March	5	4th Satell.	10 7 3·5	11 49 30·4	Greenwich M.T.	271
	6	2d		11 19 53·9	——	180

"On March 5, while waiting for the emersion of the 4th satellite, I observed the contact and separation of the 2d and 3d satellites. One passed so nearly over the other, that at one time the elongation was only just perceptible.

	Greenwich M.T. h m s		Greenwich M.T. h m s	Power.
Contact	14 42 32·5	Separation	14 52 40·9	271

ENCKE'S COMET.

CAMBRIDGE, U.S. (Professor W. C. Bond.)

1848.	Cambridge M.T. h m s	R.A. Jan. 1, 1848. h m s	Decl. Jan. 1, 1848. ° ′ ″	No. of Obs.	Star of Comp.
Aug. 27	14 1 44	3 19 28	+31 57 1	1	
29	12 50 53	23 31·2	32 36 29	13	*a*
30	12 57 36	25 46·2	32 57 47	11	*b*
31	12 40 1	27 58·9	33 19 3	10	*c*
Sept. 5	15 56 49	3 40 36·2	35 17 13	6	*d*
26	11 26 24	5 7 49·4	46 23 42	10	*e*
Oct. 8	16 35 57	7 26 35·9	53 3 36	6	*f*
27	17 30 39	12 19 51·7	25 5 29	8	*g*
Nov. 3	17 33 38	13 7 48·4	11 6 18	6	*h*
5	17 29 34	18 14·7	+ 7 43 58	6	*i*
13	17 56 8	13 53 52·5	— 3 34 57	10	*k*
20	18 17 33	14 25 18·8	11 38 55	4	*l*
25	18 5 20	14 52 59·4	−16 44 49	4	*m*
Nov. 21	18 17 02	Comet precedes Mercury	$7^{m}\ 29^{s}\cdot35$	by two comps.	
	18 5 36	— North of —	5′ 44″·3	by one ,,	

"All the above positions have been determined with the *Micrometer* of the great equatoreal, with the exception of those on the 27th of August and the 25th of November, on which occasions the declination and hour-circles were used. The comet's places are corrected for refraction, but not for parallax. The places of the stars which follow are mostly from our own determinations.

Mean Places of the Stars of Comparison, January 1, 1848.

Star	R.A. h m s	Decl. ° ′ ″	Mag.	
a	3 23 40·54	+32 30 54·3	10	
b	3 26 5·22	33 1 38·3	11	
c	3 29 19·00	33 21 23·7	9	
d	3 40 41·87	35 15 19·2	9	
e	5 8 14·79	46 27 33·2	9	
f	7 27 56·10	53 0 51·6	7	
g	12 19 58·13	25 4 7·1	8	
h	13 8 9·51	11 3 15·7	9	B. Z. 232
i	13 19 55·74	+ 7 42 4·0	9	
k	13 53 48·30	— 3 34 45·6	8	
l	14 28 55·07	11 39 20·5	7	B.A.C. 4828
m	14 42 28·75	−15 24 24·0	3	— 4895

"August 27. The comet is faint and without concentration; its light is coarsely granulated, so that, were it not for its motion, it might be mistaken for a group of very small stars.

"September 26. A faint brush of light extends from the comet *towards* the sun.

"October 6. The comet is just visible to the naked eye. The brighter part is very eccentrically situated with reference to the general mass. A fan-shaped brush of light is very evident on the side *towards* the sun. There is no other appendage which can be called a tail.

"October 27. A faint ray of light is now seen directed from the sun.

"November 3. The comet shews a tail of one or two degrees, directed *from* the sun; with the same appearance on the opposite side as in October.

"November 5. The star of comparison is double, Dist. = 10″; that north preceding is used.

"November 21. The comparisons with *Mercury* have been corrected for refraction and for the planets' motion in the intervals of transit.

"November 25. At the first observation the altitude of the comet was 4°. The star was observed at nearly the same altitudes with the comet, so as to diminish the effect of errors in the refraction tables.

"The place given is probably accurate to within 0ˢ·5 in right ascension, and 5″ or 10″ in declination."

PETERSEN'S SECOND COMET.

CAMBRIDGE, U. S. Equatoreal. (Professor W. C. Bond.)

1848.	R.A. h m s	Decl. ° ′ ″	No. of Obs.	Star.
Nov. 25	6 56 41	20 35 11·2	+37 24 15	2	*a*
27	6 58 34	20 43 45·8	34 52 24	6	*b*
28	6 55 53	20 47 58·3	33 34 54	3	*a*
29	6 55 16	20 52 10·5	32 16 4	1	*a*
30	8 20 36	20 56 35·6	30 51 18	3	*c*
Dec. 18	7 18 45	22 4 15·3	6 13 2	3	*d*
19	7 34 9	22 7 39·0	+ 4 54 25	4	*e*
1849. Jan. 22	6 42 22	23 42 13·2	−27 10 19	2	*f*

Corrected for Refraction and referred to the Mean Equinox, Jan. 1, 1848.

Mean Places of Stars of Comparison for 1848.

	R.A. h m s	Decl. ° ′ ″	
a	20 40 3·75	+33 24 13·8	ε Cygni
b	20 43 12·06	35 0 15·5	Lalande, 40277
c	20 59 22·45	30 57 32·7	B. Z. 306
d	22 4 19·51	6 8 58·3	Weisse, xxii, 78
e	22 6 25·42	+ 5 1 41·0	— —, 124
f	23 36 34·00	−27 5 15·9	Lalande, 46511

"The places on the 25th, 28th, and 29th of Nov. are from instrumental comparisons; the remainder are from micrometric differences, which were susceptible of great nicety, as the centre of the comet was indicated by a finely marked nucleus. On Nov. 30th, the nucleus passed within one second of arc of a star of the 12th mag., forming a close double star, but the contact was not complete. At the time of nearest approach the comet could be *seen to move*."

MARKREE. Large Equatoreal. (E. J. Cooper, Esq. and Mr. Graham.)

1848.	Greenwich M.T.	R.A.	Parall. Factor.	Decl.	Parall. Factor.	No. of Comp.
	h m s	h m s		° ′ ″		
Nov. 1	10 28 25·3	18 45 24·19	+[9·824]	+59 46 48·1	+[0·529]	10
2	8 58 8·0	49 45·53	9·777	59 10 46·0	0·251	8
3	7 54 38·4	18 54 12·53	9·691	58 32 54·1	9·927	10
7	7 43 48·1	19 12 47·86	9·635	55 41 5·0	0·016	10
14	7 54 33·1	19 45 17·39	9·585	49 40 58·0	0·280	10
20	8 43 53·1	20 12 41·88	9·599	43 27 34·5	0·513	5
22	7 7 33·7	20 21 17·60	9·498	41 15 21·6	0·396	5
29	7 47 31·5	* + 5·27	9·444	* −14 22·5	0·592	10
Dec. 8	7 14 17·7	21 27 29·44	9·321	20 9 44·9	0·707	10
14	6 55 30·4	21 49 36·53	9·254	11 51 5·7	0·771	5
19	6 52 24·9	22 6 55·93	9·245	5 12 28·4	0·813	10
22	6 40 13·2	16 50·01	9·209	+1 25 25·7	0·833	5
23	7 41 1·3	* − 22·83	9·369	* −2 55·7	0·840	5
27	6 30 14·7	22 32 34·31	+[9·189]	−4 28 18·2	+[0·860]	5

The Parall. Factor is the log. of the number which, when divided by Δ, gives the correction for parallax in seconds of time and of arc, for R.A. and Decl. respectively.

Stars of Comparison and Notes.

Nov. 1. Piazzi, 18h: 220; 223.
2. B.A.C. 6463.
3. App. R.A. = 18h 52m 7s·88, Decl. = +58° 33′ 9″·3, meridian circle.
7. App. R.A. = 19h 11m 17s·23, Decl. = +55° 41′ 2″·9, ditto.
14. H.C. 37777.
20. — 38982, 6; 38990, 1; B.Z. 322: 20h 9m 25s·14; 29s·40.
High wind. The observation cannot be depended on.
22. H.C. 39393.
29. Rough place of star, R.A. = 20h 51m 29s, Decl. = +32° 43′.
Dec. 8. B.Z. 196: 21h 36m 31s·00; 27m 33s·07; 28m 12s·00.
Blowing pretty hard.
14. H.C. 42762. Weisse xxi: 1155.
19. Weisse xxii: 124.
22. — — 380; 391.
23. Rough place of star, R.A. = 22h 20m 35s, Decl. = +0° 11′.
27. H.C. 44337, 8, 9.

DURHAM. Fraunhofer Equatoreal. (Prof. Chevallier and Rev. R. A. Thompson.)

1848.	Greenwich M.T.	R.A.		N.P.D.		Obs.
	h m s	h m s		° ′ ″		
Nov. 24	10 2 10·7	20 30 34·15	+·049 P.	51 16 21·0	−·60 P.	5
30	10 33 11·6	20 56 9·14	·044 P.	58 59 43·2	·72 P.	3
Dec. 11	9 29 13·7	*a* +1 21·97	·039 P.	*a* +5 22·3	·74 P.	6
16	8 38 54·5	*b* −2 8·60	·035 P.	.....	.....	1
	8 44 13·3	....		*b* −6 37·8	·77 P.	1
28	7 19 22·3	22 35 41·26	+·028 P.	95 37 31·8	−·85 P.	4

P is the horizontal parallax expressed in arc.

Stars of Comparison.

			R.A.	N.P.D.
			h m s	° ′
Nov. 24	B.A.C. 7167	Dec. 11	21 37 43	74 5
30	H.C. 40654	16	21 59 5	81 4
Dec. 28	H.C. 44612			

"The places of the catalogued stars are taken from the authority cited. The first and last observations were made with the wire micrometer and red illumination; the others with the bar micrometer, without illumination.

"On Nov. 24, $11^h 2^m 30^s$, Greenwich M.T., the nucleus was close upon a fixed star, the place of which by two comparisons with B.A.C. 7167 was found to be—

R.A. ..... 20 30 46·83 N.P.D. ..... 51 19 41·9

"The star was seen as before, but the comet appeared much fainter when near it."

Elliptic Elements of Petersen's Second Comet. By T. H. Safford.

Per. Passage,	Jan. $19^d{\cdot}35269$	1849, Greenwich M. T.
Long. Per.	63° 14′ 31″	
Node	215 13 1	
Inclin.	85 3 3	
Log. Per. Dist.	9·9821429	
Log. Eccentricity ...	9·9999210	
Log. Mean Dist.	3·7219822	
Period	382801 years.	

From observations, Oct. 25th, Dec. 18th, 1848; and Jan. 22d, 1849.

Professor Schumacher writes,—"I have received from Dr. D'Arrest, now assistant at the Leipzig Observatory, his third elements of Dr. Petersen's Second Comet, they are corrected after his observations made on Jan. 8, 9, 12, viz.:—

	Leipzig M.T.	R.A.	Dec.
	h m s	° ′ ″	° ′ ″
Jan. 8	4 57 59	346 39 44·6	−16 23 48·4
9	5 38 43	347 19 3·7	17 14 51·5
12	6 11 56	349 16 42·8	−19 45 44·5

"The elements of Dr. Petersen give the differences:—

	In R.A.	In Decl.
	″	″
Jan. 8	−0·3	+52·6
9	−4·8	+39·2
12	+5·8	+56·1

"The second elements of Dr. D'Arrest,—

	″	″
Jan. 8	+17·1	+ 6·7
9	+10·6	−11·0
12	+22·0	− 4·6

"His third elements, which he considers as very accurate, are the following. There seems to him not the least indication of ellipticity yet given by the observations.

Time of Perihelion Passage, 1849, Jan. 19, 39001, Berlin M.T.

	°	′	″	
π	63	14	38·0	Mean Eq^{x}. 1849·0
Ω	215	12	50·4	
i	85	2	50·6	

Log. q 9·9821197

Motion Direct.

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*Substance of the Lecture delivered by the Astronomer Royal on the large Reflecting Telescopes of the Earl of Rosse and Mr. Lassell, at the last November Meeting.**

The Astronomer Royal gave that evening an account of the large reflecting telescopes of the Earl of Rosse and Mr. Lassell, which he had personally examined in the course of the last summer.

Premising that the subject might be considered interesting to the Society on these two grounds, first, that the reflecting telescope is exclusively a British instrument in its invention and improvement, and almost exclusively so in its use; and, secondly, that it had been almost exclusively the instrument of amateurs — a circumstance which seemed to prove both the difficulty of constructing it and its great excellence when properly constructed, — the Astronomer Royal remarked that his account would consist in some measure of a statement of the differences between the processes of these two amateur constructors. These differences, he thought, would be found well worthy the attention of all who were engaged in or contemplated the construction of reflecting telescopes. It is certain that both systems of methods are successful; and it may be doubtful how far the differences are connected with the difference of dimensions of the telescopes: for in all that follows it must be borne in mind that Lord Rosse's largest telescopes are 6 feet in clear aperture and more than 50 feet in focal length, while Mr. Lassell's are 2 feet in clear aperture and about 20 feet in focal length; that the thicknesses of the specula are nearly in the same proportion as their diameters; and hence that the weights of the specula are nearly as 27 to 1 (that of Lord Rosse's being about four tons, and that of Mr. Lassell's being about three hundredweight), a difference which in itself might be expected to require some difference of construction.

I. The first difference is in the constitution of the metal-mixture used for the speculum.

In Lord Rosse's specula the metal is purely a mixture of tin

* The Astronomer Royal has been kind enough to furnish this account at the *urgent* request of the Editor, though with great inconvenience to himself. The polishing apparatus of Lord Rosse is described in his paper, *Phil. Trans.* 1840, p. 515, and figured in plate xxi. The polishing apparatus of Mr. Lassell is figured in his memoir, which is ordered for publication. Fellows can see models of both, and of Lord Rosse's gigantic reflector, at the apartments of the Society.

and copper, in a proportion understood to be an atomic proportion, the weight of the copper being something more than double that of the tin. In the process itself there appears to be strong evidence that this proportion is truly atomic. When the metals are mixed in the intended proportions, it is found that the addition of one or two ounces of either metal to a mass of forty pounds of the mixture produces a difference so striking, that it is at once recognised by every person who is employed on the works. The mixed metal, when in fusion, possesses a remarkable union of penetrating power and of viscidity. It is so penetrating that Lord Rosse found it impossible to retain it in the ordinary cast-iron crucibles, which are cast with the mouth downwards; and he was compelled to have crucibles made expressly for this purpose, cast with the mouth upwards. It is at the same time so viscous, that when, in the casting of the speculum, the liquid metal is poured upon what Lord Rosse calls a "bed of hoops," that is, a broad base of the mould, formed by pressing together the flat surfaces of a great number of iron hoops, whose edges (trimmed into shape by turning and other mechanical operations) form the base, and through the interstices of which the air can escape; the metal itself does not in the smallest degree enter into these interstices. As soon as the cooling metal has acquired some consistency, it is dragged into the annealing furnace, every part of which has been brought to a low red heat. Great attention is given to the form of the floor of this furnace, as the metal is still in such a state that it receives figure from the furnace-floor. The furnace is then closed (care being taken to prevent one part from cooling, by radiation or convection, more rapidly than another), and after some weeks it is opened and the metal is taken out.

In Mr. Lassell's specula, the metal is made by first mixing copper and tin in the same proportions as those employed by Lord Rosse, and then adding a small quantity of white arsenic. It is well known that very great importance was attached to the admixture of arsenic by the principal constructors of reflecting telescopes in the last century. Lord Rosse has uniformly stated it as the result of his experience that, when the copper and tin are properly proportioned, nothing is gained by adding arsenic; Mr. Lassell is equally confident that the brightness of the metal is much improved by it. It would be idle to express an opinion on this point without comparing specimens of the two kinds of speculum-metal, side by side; and the Astronomer Royal only undertook to say that both bear a very high polish. The Astronomer Royal believed that the operation of annealing Mr. Lassell's mirrors was nearly similar to that for Lord Rosse's, although the trouble and risk of the process are of course materially diminished by the much smaller dimensions of the speculum.

The next step in Lord Rosse's operations is to turn (by a grinding process, with emery as the abrading powder) the edge of the mirror, the mirror being placed with its broad surface horizontal, with its lower surface and about one-third of its depth immersed in

water, and being turned horizontally by a vertical spindle passing through a stuffing-box in the bottom of the water-vessel. The purpose of this turning is, to make a nearly air-tight fitting for a covering which is to be applied to the mirror when it is not in use, and with which is connected a box of quicklime, for the desiccation of the air in contact with the mirror; and the object of turning it in water is, to keep all parts of the speculum in the same temperature, a caution which is necessary in every part of the operations. This caution is probably requisite only for specula as large as those of Lord Rosse. For these it was found by Lord Rosse that if the iron grinder (to be mentioned presently) be washed with warm water, and be then applied to the speculum, the metal almost infallibly cracks. A surface of warm pitch may, however, be applied without producing the same bad effect.

II. The subject next worthy of attention, rather for the similarity of the methods of the two constructors than for their dissimilarity, is the method of mounting the mirrors. And this seems to be a proper place for mentioning the mounting, because it is indispensable (at least with Lord Rosse's specula) that the mirror be ground and polished on the very same supports, applied in the very same manner, as when the mirror is in use in the telescope.

The special object of Lord Rosse's support is this: supposing the surface of the speculum to be divided into any number of equal portions, each of a form not particularly elongated in any direction, then the supports are to be so arranged that every one of these portions shall necessarily sustain the same upward pressure, acting at its centre of gravity. At the same time it is necessary, for definiteness of support, that the ultimate support upon the fixed frame be upon three points. These objects are thus attained: the surface of the mirror is divided into twenty-seven equal portions, and these are grouped into nine groups, of three in each; to each portion is attached, by felt and pitch, a small plate of cast iron; and in a small hole sunk in this cast iron, opposite to the centre of gravity, a projecting pin of a triangular plane lever takes its bearing. This triangular plane lever is merely a triangle, having three points to sustain pressure, and a small hole for the fulcrum at the centre of gravity of the three points considered as equal weights; it is, then, evident that if that point is made really the fulcrum, the pressures at those three points are necessarily equal. The same construction being applied to each of the nine groups, then it is only necessary to support the nine fulcra in such a way that the pressures upon them are necessarily equal; and this is done by grouping three of their fulcra as points of pressure upon the three points of another and stronger triangle, whose fulcrum is at the centre of gravity of these three points considered as equal weights; and this fulcrum is one of the points of the fixed frame. It will thus be evident that every one of the first-mentioned pins sustains exactly one twenty-seventh part of the whole weight of the mirror, or rather of the whole pressure of the mirror perpendicular to its surface, neither less nor more. (When the mirror is in the telescope,

it exerts also an edgewise pressure, which in Lord Rosse's construction was at first sustained by fixed pillars of the fixed frame; of these more will be said hereafter.) The fixed frame has small wheels; while it is in the grinding trough, it is so lifted off the wheels that it takes a firm bearing upon the rotating-frame; when it is to be carried to the telescope it is lowered to take bearing upon its wheels, the side of the grinding-trough is taken off, the fixed frame carrying the speculum is wheeled upon a proper carriage, the carriage conveys it to a place very near the telescope, where is a railway at proper height for receiving the small wheels; the telescope is placed vertical, its lower end is opened, and continuation-rails are laid to it, and the fixed frame is thus wheeled into the telescope, carrying the mirror; then by powerful screws the bearing of the fixed frame is received upon three points, the wheels being entirely lifted off their bearings. (Since giving this account, the Astronomer Royal has learnt from Lord Rosse that a speculum which was raised for a few minutes only from its lever-bearings received in that time a permanent change of figure.)

In Mr. Lassell's operations the speculum is supported on eighteen points, the grouping being first made by two and two, with straight levers, and then the fulcra of the straight levers being by means of triangular levers supported upon three ultimate points. The Astronomer Royal was not able to say whether the same cautions, as to retaining the speculum at all times upon the same bearings, which Lord Rosse found necessary, were required for Mr. Lassell's mirrors; but it is evident that the difficulties of support of every kind are here very much less. The edgewise pressure, when in the telescope, is here supported by a semicircular iron hoop, of which more will be said hereafter.

III. The next point deserving special comparison is the apparatus for grinding and polishing.

The apparatus used by Lord Rosse imitates very closely, but with that superior degree of regularity which is given by machinery, the operation of polishing by hand. Proceeding from the quick motions to the slow ones, the order of movements is as follows:—(1.) By a steam-engine, a rotatory motion round a vertical spindle is given to a crank, which by a connecting rod acts upon a sliding rod that moves the grinder or polisher backwards and forwards. This sliding rod passes through a fixed guide at the end next the connecting rod, and through a slowly moving guide [described under (2)], at the other end; and thus every stroke of the grinder is very nearly a straight stroke. The sliding rod is interrupted in its middle, and there its place is supplied by a hoop which loosely surrounds the grinder: this construction is necessary, because, on account of the great size and weight of the grinder, it is necessary that it be supported by counterpoises in various parts, at the same time that it is necessary that (in order to prevent the formation of striæ in a definite direction on the grinder) the grinder be left free to revolve: that motion of revolution is given merely by the friction

upon the mirror, whose rotation will be mentioned under (3), and depends upon the weight with which the grinder presses the mirror. (2.) A band from the crank-spindle (1) passes round a wheel which carries a crank, in which is the forked guide (turning by a spindle in the crank end), that guides the distant end of the sliding rod; and thus the strokes of the grinder do not pass uniformly over the centre of the mirror, but pass in their direction a certain distance to the right and left. But as, in the ordinary crank motion, the duration of the strokes at the extreme right and left would be too great, the wheel on the spindle of this grinding-crank is elliptical, the proportion of its axes being about three to one: its angular motion is, therefore, unequal; and the strokes are thus made to dwell a shorter time near the extreme right and left, and a longer time near the centre. (3.) Another band from the crank-spindle (1) passes round a large wheel on the vertical axis, that passes through a stuffing-box in the bottom of the grinding-trough, and there carries a broad frame, on which is placed the fixed frame of the mirror, supporting the mirror itself. Thus the mirror turns slowly round to receive the strokes of the grinder in every direction. It is only necessary to add to this, that a large part of the grinder's weight is equally supported at twelve points, by a lever counterpoise above it, which supports the centre of a triangle, each point of which (by a roller over which a cord passes) supports two points, each of which points is the middle of a straight lever whose ends are attached to the grinder.

In Mr. Lassell's apparatus (omitting some details, which are not now necessary, as a detailed account of this apparatus has lately been given by Mr. Lassell himself to the Society), the steam-engine puts in motion (1) a vertical spindle below, which turns the mirror slowly, and (2) a vertical spindle above, which has a horizontal arm, in which is a planet-wheel turned by its tooth-connexion with a fixed sun-wheel. The axis of this planet-wheel carries another wheel that works in a third wheel, whose spindle is carried by the horizontal arm, but whose place can be fixed at pleasure near to or far from the centre of the vertical spindle (2). An arm from the spindle of the third wheel carries a spike pointing downwards (the distance of this spike from the centre of the spindle of the third wheel being adjustable), and this spike lodges loosely in the centre of the grinder and moves it upon the face of the mirror. Thus it will be seen that the centre of the grinder is always moved in an epitrochoid (including the circle as a possible case, if the adjustment is made for that curve), in which the proportion of velocities of the two circles is fixed, but the radii and their proportions are adjustable. The grinder, as in Lord Rosse's construction, is allowed to take freely the rotatory motion which it may receive from the friction on the mirror; but no counterpoise is used, the weight of the grinder being comparatively small.

The essential difference of these constructions, as regards the movements of the grinder, is, therefore, this: that in Lord Rosse's

apparatus every stroke is very nearly straight, while in Mr. Lassell's apparatus there is no resemblance to a straight movement at any part of the stroke.

IV. The process of grinding is nearly the same (with differences corresponding to the difference of dimensions) in the operations of both constructors.

In Lord Rosse's grinding, the speculum having received an approximate figure from the form of the annealing furnace, the cast-iron grinder is brought very exactly to form by turning upon the lathe, with proper reference to a gauge, and (if not done before) its surface is scored with cross-furrows about two inches apart and nearly an inch deep, leaving the acting part of the surface in squares. The grinder is then mounted in the apparatus; and this is the most dangerous part of the whole operation. The slightest jar of the iron grinder upon the mirror would break the mirror; and to avoid this risk, a great number of thin wooden wedges is placed upon the edge of the mirror, the grinder is slowly lowered upon them, and then by degrees they are gently withdrawn. The grinder is then used to grind the surface, with the intermediate powder of emery and water; coarser and finer emery in succession. A heavy weight is allowed to press the grinder upon the mirror; and as the grinder itself suffers much in form, it is repeatedly re-turned upon the lathe. This operation sometimes lasts many days.

Of the grinder used by Mr. Lassell, the Astronomer Royal could give no account, but believes that it is of wood, the same which is used for polishing. The abrading powder used is the same as Lord Rosse's (emery, coarser and finer in succession).

V. The next point deserving attention is the important process of polishing.

When the figure of the speculum given by grinding is supposed by Lord Rosse to be sufficiently accurate, the projecting squares of the cast-iron grinder are covered with a coating of resin and turpentine, of such a consistence that, at a temperature of about 50° Fahrenheit, the nail can easily make an indentation in it. This is then covered with another coating, of a substance formed by combining the mixture last-mentioned with a certain quantity of wheat-flour, and of such a consistence that, at a temperature of 80° Fahrenheit, the nail can make an indentation in it. It is not to be understood that there is any particular virtue in the temperatures 50° and 80°, but (for reasons to be hereafter given) it is necessary to have two strata of different degrees of hardness (the harder being the exterior), and the hardnesses defined by those two temperatures having been used in many experiments, the other adjustments have been determined, using these as bases; and if these bases were now changed, every other adjustment must be changed.

The necessity for the different strata of resin is thus explained. It is necessary that the polisher yield a little, else the polishing surface could not be in contact with the mirror at all parts of its stroke (the mirror being supposed parabolical), and this yielding is given by the first or soft stratum. But it is also necessary that the

stratum next to the metal be hard; for if, in passing across a scratch or furrow, it were able to accommodate its form to that of the furrow, it would round off and polish the edges of the furrow, and this would very much injure the image of a bright object.

The coating is heated to softness by the flame of a torch, and the grinder is then lowered upon the mirror, and the coating takes the proper form. The mirror is exposed to no danger of cracking from this application.

The powder used is the red oxide of iron, prepared by precipitating (by means of ammonia) the black oxide of iron from a solution of sulphate of iron, and then heating the black oxide in a furnace with access of air. Lord Rosse finds that no other method of preparing the red oxide is successful. No polishing-putty or other powder of any kind is employed.

The powder is moistened with water to a degree known by experience, and then, the counterpoise of the grinder being so much increased that the remaining friction is enough to turn the grinder only once for about sixteen revolutions of the mirror, the operation goes on for about eight hours. It is essential, for reasons similar to those lately mentioned, that the temperature of the air and the temperature of the dewpoint have nearly certain definite values (the latter, that the water mixed with the powder may dry in the proper degree): if the external air is too dry, the air of the room is moistened by a jet of steam; if it is too damp, the polishing is not attempted.

After about eight hours, the grinder is lifted and a fresh application is made of powder mixed with "ammonia soap," a substance formed by treating common soap with ammonia. The metal then dries more rapidly, and the labour to the engine becomes much greater: the work is continued till the surface is dry, or very nearly dry; the grinder is taken off, and the mirror is found finished, having a parabolic figure, and a very high polish.

It is to be remarked here that the smaller mirrors made by Lord Rosse (3 feet diameter, about 25 feet focal length) were tried before they were used, by means of an object fixed something more than 50 feet above them, whose image accordingly is found at something less than 50 feet above them. But for the larger mirror, such a trial is impracticable (the height of the object must exceed 100 feet), and the mirrors have, therefore, been placed in the telescope without any trial, and their definition has been found perfect.

Mr. Lassell uses for polisher a wooden plate formed of two thicknesses of pine-wood with the grain crossed; and this apparently yields to accommodate itself to the form of the mirror. In the arrangement of its square protuberances, it is similar to Lord Rosse's; but it is covered with only one coating of pitch. The polishing powder used is the same as Lord Rosse's. The Astronomer Royal believed that the attentions to temperature, moisture, &c., which Lord Rosse found indispensable for his large mirrors, are not found necessary by Mr. Lassell. Mr. Lassell finishes the operation with the speculum wet.

VI. The next point to which allusion was made is the form and mounting of the telescopes.

Lord Rosse's telescope is a wooden tube, its interior diameter exceeding 6 feet in every part, being at the middle about 7 feet, and nearly 50 feet in length. This is fixed to a cube of 10 feet, which has folding-doors on that side which, when the telescope is horizontal, is the upper side (at which side the fixed frame supporting the mirror is introduced, as has already been said), and which carries the fixed frame by three large screws in that side of the cube which is opposite the mouth of the telescope. To this side of the cube is attached the universal joint by which the lower end of the telescope is connected with a fixed support, the joint being a few feet below the general surface of the ground. On each side (east and west) of the telescope is an enormous pier of solid masonry, about 70 feet long, in the north and south direction, between 40 and 50 feet high, and in its thickest part nearly 20 feet thick. (None of these dimensions are taken from actual measure.) The fixed support is nearer to the north than to the south ends of these piers. Near the top of the piers, on the interior faces, in the east and west plane passing through the universal joint, are two cranes with pulleys (the turning crane being no bigger than suffices to carry a large pulley, whose edge is in the vertical axis of the crane); over these cranes the chains pass which are attached to the telescope; and to the lower ends of the chains, after they have passed fixed pulleys on the walls, are attached the counterpoises, weighing about four tons each. These counterpoises are not allowed to depend freely, but are connected by bridle-chains with wooden horns that project from the north ends of the piers; the effect of this arrangement is that when the telescope tube is nearly horizontal and the force required to support it is very great, the weight of the counterpoises acts very nearly vertically on the chains, and is entirely effective for the support of the telescope; but when the telescope is considerably elevated and less supporting force is required, the weight of the counterpoises is supported in a great measure by the bridle-chains, and very little tension is given to the supporting chains. For the sake of supplying some slight defects in the laws of tension thus produced, and also for the sake of constantly producing a small tendency in the telescope towards the south horizon, other counterpoises, in a pit south of the fixed support, are brought successively into action as the telescope is raised. There is then only a comparatively small and very manageable tendency of the telescope towards the south, and this is supported by a light chain which passes over a pulley on a bar connecting the horns before mentioned (the pulley being in the direction of a polar axis passing through the lower universal joint, and the motion of the telescope, therefore, for a given length of the chain, being equatoreal), and this chain is shortened or lengthened, and the telescope is thereby raised or depressed, by a windlass a little way north of the fixed support. Upon the inner face of the eastern pier is an iron arc of a circle, upon which slides a runner

connected with a rod that passes through a frame on the telescope-tube and near to its mouth, and is there racked for working with a pinion: by the movement of this pinion the distance of the telescope from the pier is altered, and thus a motion in hour-angle is given. At the south ends of the piers there are strong ladders, upon which (assisted by counterpoises) there slides a stage; upon which stage a small observing box travels east and west: this is used for observing, so long as the mouth of the telescope is below the end of the pier. For greater elevations, the top of the western pier being shaped by slopes so as to approximate to a circular arc, there are mounted upon it curved galleries, which are carried by beams that run above and below pulleys fixed to the top of the pier; and the galleries are carried out by rack-and-pinion work, to approach the side of the telescope. It is intended to give the power of observing as far north as the pole; but at present the galleries extend only to the zenith. The telescope is Newtonian, the minor axis of the small mirror being about six inches, and the observer looks into the side of the tube.

Mr. Lassell's tube is of sheet iron, and this tube is not carried immediately by the mounting, but is inserted in a long box of cast iron, in which it can be turned round its own axis. This movement is necessary to place the eyepiece exactly in the same side-position in all directions of the telescope, and also to cause the edgewise support of the mirror to act always in the same way. The long box is mounted equatoreally, the polar axis turning in two bearings below the declination axis, and carrying an hour-circle, upon which are fixed two supports, in which turn the two pivots of the declination axis of the long box. The telescope is Newtonian, the eyetube being in one side; but the smaller dimensions of the small mirror (a diameter of 2 inches only being required) enable Mr. Lassell to use the reflection at the internal surface of a glass prism, by which much more light is reflected than by a metallic reflector. At first much annoyance was caused by the deposition of dew on the glass, but this was remedied by attaching to it a case carrying a small piece of heated lead; and, when proper attention is given to the inclosure of the lead, no inconvenience is sustained from the effect of the hot metal in disturbing the air in the tube of the telescope. The whole is covered by a revolving dome 30 feet in diameter, and the observer is mounted for observation on a stage which is carried by the dome.

The Astronomer Royal then proceeded to describe some of the difficulties to which instruments of this class are yet liable, founded partly upon his own observations with Lord Rosse's telescope.

Upon directing the telescope to an object very near the zenith, it was seen very well defined; or, at least, with no discoverable fault. It must be remarked that the image of a star never assumes the neat spherical form to which the eye of an observer with a fine refractor is so much accustomed. This arises evidently from the circumstance that (from the great aperture of the mirror) the diffraction image and diffraction rings are invisibly small, and the

form of the blurred image is probably determined by the irregular sensibility of the nervous membranes of the eye. The same effect exactly is produced by a large refractor when a power is employed too low to exhibit the rings.

But when the telescope was directed to a star as low as the equator its image was very defective. The defect, however, followed that simple law which the present Master of Trinity College has described by the word *astigmatism*. When the eyepiece was thrust in, the image of the star was a well-defined straight line, 20 seconds long, in a certain direction; when the eyepiece was drawn out a certain distance (about half an inch from the former position) the image of the star was a well-defined straight line, 20 seconds long, in a direction at right-angles to the former. Between these two positions the image was elliptical, or, at the middle position, a circle of 10 seconds diameter. The image of *Saturn* (then without a ring) was, in the two positions above mentioned, an oval (not an ellipse), whose length was about double its breadth; or, in the middle position, it was a confused circle, whose diameter was about 30 seconds instead of 20. The position of the astigmatic lines had no distinct relation to the vertical plane; and this circumstance, as well as the magnitude of the astigmatism, proved that it was not produced by a tilt of the mirror.

Lord Rosse immediately suggested a probable cause of this defect. The triangular levers which support the mirror are all, to a certain degree, elastic. When the telescope is dropped from the vertical position, the edge of the mirror begins to press the fixed pillars in the fixed frame mentioned under No. II.; and as the edgewise pressure increases faster than the excess of the elastic force of the levers over the pressure on the levers, the edge is firmly locked to the pillars by the friction against them. When the telescope is much depressed this friction is perhaps not much less than two tons, or is equal to the greatest strain of six horses, all exerting a force perpendicular to the face of the mirror at a part intended to sustain no such force, and therefore tending to bend the mirror out of shape. The obvious remedy was to suspend the edge of the mirror in such a manner as to leave it free to play in a direction perpendicular to the face of the mirror; and for this purpose, first an iron hoop, and secondly a chain, were used, the bearing against the pillars being entirely destroyed. The effect was at first very satisfactory; definition was made very good; *Saturn's* ring was well seen on September 2 as a narrow line. But in subsequent observations the effect was not so satisfactory. Here, again, Lord Rosse discovered the cause. The triangular levers which immediately support the mirror are necessarily not plane, inasmuch as the points which take hold of the plates that adhere to the mirror must project higher (the telescope being vertical) than the fulcra of these levers. If, then, when the telescope is lowered, the mirror is allowed to slip edgewise, it throws the lower points of each lever partly out of bearing, and then the mirror is not supported

in the way to which its figure is adapted. It was found that some of the points were not in bearing; and it was also found that, when the telescope was directed to a star, the image was rendered extremely good by screwing or unscrewing to the proper degree the supports of the hoop or chain. It was found, moreover, that all this adjustment was affected by the bending of the iron base of the fixed frame. On the whole, this part of the mounting is not in a satisfactory state. The Astronomer Royal was not able to say what is the nature of the edge-bearing adopted by Lord Rosse at the present time; still it is evident that, with due attention, the mounting above-mentioned may be made perfectly available. [The Astronomer Royal has lately been informed, that Lord Rosse has entirely overcome these difficulties, by placing, between the back of the mirror and the plates in which the points of the triangular levers act, sheets of tin, which allow the mirror to slip upon the plates, instead of the felt and pitch, which formerly united the mirror and the plates.] It may be proper here to mention, that Lord Rosse has informed the Astronomer Royal, that the mirror which he saw under the polisher has been mounted, and that it shews very well the third star of γ *Andromedæ*,—no small proof both of the perfection of the figure and of the efficiency of the support of the mirror in that position.

The Astronomer Royal then explained his own ideas upon the nature of the mounting, to which (whatever might be the practical difficulties in the mere mechanical operation) he thought it would be necessary to approach. He thought that it was absolutely necessary to give the edge-support by counterpoises; and this might be done, retaining the present levers, by making the point of each of the small triangles a socket for a ball-and-socket joint, in which turns a lever whose point lodges in the mirror. The extreme hardness of the speculum metal makes it, however, difficult to drill the holes.

In terminating now the account of the mirror, the Astronomer Royal alluded to the impression made by the enormous light of the telescope; partly by the modifications produced in the appearances of nebulæ figured by Sir John Herschel, partly by the great number of stars seen even at a distance from the Milky Way, and partly from the prodigious brilliancy of *Saturn* (the only planet which he had an opportunity of seeing). The account given by another astronomer of the appearance of *Jupiter* was, that it resembled a coach-lamp in the telescope; and this well expresses the blaze of light which is seen in this instrument.

The Astronomer Royal then stated that he had had no opportunity of trying Mr. Lassell's telescope; but he had understood from Mr. Lassell that some difficulties had been found in the arrangement of the edge-bearing of the mirror, which had been overcome by suspending it in an iron hoop. These, however, from the great difference of dimensions, would probably be trifling compared with those of Lord Rosse's mirrors.

Adverting again to the mounting of these telescopes, the Astro-

nomer Royal suggested for consideration whether it might not be advantageous to mount the telescope with an altitude and azimuth movement, by an overhanging fork inserted in a vertical pillar. If a rod were joined to the stalk of this fork, and, by means of an ordinary parallel motion, were compelled to move parallel to the axis of the telescope, and if any part of this rod were connected by another rod (adjustable in length according to the polar distance of the object) to a universal joint on the ground, in such a position that the line drawn from that universal joint to the stalk of the fork is a polar axis, then the motion of the telescope would be equatoreal. For the observer, it was proposed that an observing-box should be fixed to the telescope, and that the access should be by a spiral staircase round the pillar, by a narrow platform near its top, and by a staircase along the side of the tube.

In conclusion, the Astronomer Royal observed that it was impossible to overrate the advance that had been made in the construction of telescopes by the two amateur constructors of whom he had spoken. Lord Rosse had shewn that it was possible, without any important manual labour, to produce with certainty, by means of machinery, mirrors of a size never before attained, and perhaps with a perfectness of definition which had not been reached before; and he had, by publication and by private communication, made these methods accessible to the world. This success was the more remarkable, because the whole of the work was done by workmen found on the spot; even the steam-engine, by which (to a late time) the whole of the machinery was driven, was made by native workmen under Lord Rosse's personal instructions. To Mr. Lassell also much was due, for the example which he had set of what may be done by a man possessing less ample means, and whose time is fully occupied in business; and much also for the elegant and compendious and manageable apparatus arranged by him, which promises to be of the greatest use in the construction of large object-glasses as well as of mirrors.

On Irradiation. By Professor Powell.

After adverting to the history of researches on this subject, the author dwells particularly on the method of exhibiting the phenomenon adopted by M. Plateau, which forms the basis of all his own experiments, and which consists of a card or lamina, cut so that one half of a long parallelogram is cut out whilst the other remains, having the portions at the sides cut away. Viewed against the light, the enlargement of the bright half, in breadth, is seen contrasted with the opaque, and might be subjected to measurement.

The first question on the subject refers to the supposition of a peculiar *physiological cause* affecting the eye to produce the apparent enlargement of the bright image. After fully allowing for some portion of such phenomena being fairly attributable to ocular

causes, such as dazzling, contrast, &c., experiments are adduced to shew that *precisely similar phenomena are produced in an artificial eye, or camera obscura;* whence the hypothesis of any peculiar affection of the retina is rendered unnecessary. The same conclusion is further confirmed by *photographic* impressions of the image of the card cut as before, which exhibit the same enlargement. Specimens of these impressions, taken by Mr. N. S. Maskelyne, were exhibited.

These results, clearly pointing to an *optical* cause, agree with the conclusions of the undulatory theory, relative to the "diffraction of a lens," as investigated by Mr. Airy, which apply to the eye considered as an optical instrument, as well as to the object-glasses of telescopes; in either case *the image of a point* being an *extended disc*, which, if the light be bright enough, will be surrounded by rings. A luminous surface will exhibit a like enlargement.

Without reference to any theory, it is an ascertained law that the enlargement *increases with the intensity of the light.* The enlargement also is formed with a rapid decrease in brightness towards the edge. On these grounds, it is easy to explain the fact of the great diminution or total destruction of irradiation by the *interposition of lenses*, which would follow immediately from the weakening of the intensity in proportion to the square of the linear magnification. The author has examined particularly into the extent to which this effect takes place, and announces that *low powers* (from 5 to 20) *are sufficient to obliterate all irradiation even in the most intense light which the eye can bear.*

Various results of M. Plateau and others as to the effects of *contrast* in making a narrow bar or wire continue visible, though the irradiations ought to overlap, have been examined, and found only to hold good with low intensities.

The author next considers the effect in *telescopes.* Here that portion of the effect which regards the *ocular* image being placed out of consideration from the influence of the magnifying power (already referred to), we have only to consider that part which affects the *focal image* of the object-glass. The *diminution of the aperture increases the irradiation;* but at the same time it diminishes the light. At a certain point, then, these two causes counterbalance each other, and no further enlargement takes place. This limit will vary with each instrument, and we have no certain grounds on which to determine it. Various observations are referred to in which its influence is evinced.

The astronomical facts connected with these causes are then examined from the testimony of various observers. In particular the application of these principles to some of those singular phenomena occasionally noticed in eclipses, transits, occultations, &c. seems easy in theory abstractedly considered. The difficulty lies in explaining why they are observed only in some cases and not in others. The author dwells particularly on the desirableness of a closer attention to stating *all* the conditions of the *telescopes* employed, especially the *apertures.*

In particular the phenomenon "*the neck*," in the transits of *Mercury* and *Venus*, would be an obvious consequence of irradiation, which would diminish the planet's disc and enlarge that of the sun, except at the small portion of the circumferences in contact, when the absence of *both* irradiations would produce a "neck."

Both theory and experiment shew that a small dark disc would have for its image a diminished disc with a bright internal concentric ring, which, if the disc be very small, will be contracted to a central bright point. This seems to agree with the appearance noticed by several observers in the transit of a white spot on the centre of the planet. On a former occasion, however, Professor Moll and others saw such a spot *excentrical*. The projection of a star on the *bright* limb of the moon would also be an effect of irradiation, which would cause the disc of the moon simply to overlap the star.

Lastly, the author suggests a method for obtaining *measures of the amount of irradiation under any given light*, by placing a card, cut as before, at the focus of a lens, opposite to the object-glass of a telescope, and attached to it by a short tube; when the enlargement of the image of the card, illumined by the light from any source, can be subjected to the exact measurement of the micrometer of the telescope.

On a New Method of Observing Transits. By A. D. Bache, Esq., Director of the American Coast Survey.

"Permit me to invite your attention, and that of the members of the Royal Astronomical Society, to a brief abstract of an official report made to me on the 15th inst. by Mr. Sears C. Walker, one of the assistants of the U. S. Coast Survey. It relates to the printing, by the use of an electro-magnetic clock, in connexion with Morse's telegraph register, of the actual dates of any celestial phenomena, which are ordinarily made the subject of observation by astronomers.

"The electro-magnetic clock of Mr. Wheatston is described in the *Proceedings* of the Royal Astronomical Society for Nov. 19th, 1841. Mr. Steinheil has described his in Schumacher's Astronomical *Jahrbuch* for 1844.

"Recently Prof. Bond and Dr. Locke have invented different processes, which are described in Mr. Walker's Report.

"Prof. Bond proposes to make circuit by the metallic contact of insulated portions of the pallet and escapement-wheel. Dr. Locke, like Mr. Wheatston, uses a metallic wheel on the arbor of the seconds' hand. This wheel has sixty teeth, each of which when horizontal strikes against a platinum lever or tilt-hammer, weighing two grains. The rising and falling of the hammer from a bed of platinum breaks and makes the galvanic circuit. The fulcrum of the tilt-hammer and the platinum bed rest severally on a small block of wood.

"The object of all these methods is to cause a delicate astronomical clock to make and break the galvanic circuit every second, without injury to the machinery or rate of the clock. The mode of action of such alternations on Morse's electro-magnetic telegraph register, as now in daily use in the United States, is the same for each of these methods.

"The *automatic clock register* thus formed consists of a graduated fillet of paper delivered pretty uniformly at the rate of an inch per second. The beginnings of minutes, and fives and tens of minutes, and of seconds, and fives and tens of seconds, are distinguished from each other by the lengths of the corresponding imprinted blank spaces. The printed second consists of an indented line of about nine-tenths of a second or less, and of a blank space for the remainder. The rate of the delivery of the paper is regulated by a centrifugal clock like those of the Munich equatoreals. An error of two seconds per minute in the rate of delivery causes only an average error of one-hundredth of a second in the register of a date.

"The printing of the date of any event not susceptible of automatic register, but dependent for our knowledge of its occurrence upon human sensations, is effected by tapping gently at this date on a *break circuit telegraph key*, so as to insert in the line of the *automatic clock register* a short blank space, whose beginning marks the instant of the tap. Should this blank space occur near that of the *automatic clock register*, the fact would identify its date. For isolated events the finger dwells long enough on the key to be sure of cutting off some portion of one of the indented lines. The dates susceptible of impression with advantage on the *automatic clock register* are such as the phases of an eclipse or occultation, or the bisections of a star or comet, or of a planet's centre or limb, by the wires of a transit instrument. The association of the nerves and sensations of sight and touch is known to be far more intimate than that of those of the eye and ear. The art of tapping at the proper dates requires far less practice and experience than that of counting beats and estimating fractions of a second. The labour of counting beats and of writing down the dates being here dispensed with, the equatoreal intervals of the transit wires may be reduced to two seconds of time, or even to less, and fifty bisections may now be registered in the same time as seven are in the ordinary way. The three advantages of Mr. Walker's method are respectively,—

"1st. The facility of acquirement of the practical skill for observing.

"2d. The *twofold* precision nearly of a single observation.

"3d. The *sevenfold* multiplication of observations in the same interval of time, or in the single transit of one, or the relative transits of two or more heavenly bodies.

"From all these sources it will be apparent that Mr. Walker's method of printing dates has nearly a *tenfold* advantage over the ordinary mode of using the transit instrument.

"A single transit of a star, or a night's or even a year's work by this method of printing, may take the place of some *ten* times those quantities by the method now in use.

"The experiment of printing the dates of bisections of transit wires by a star, on the ordinary registering fillet of Morse's telegraph, was made by Mr. Walker in 1846. It was repeated this last summer for some twenty or more stars, in connexion with Prof. Bond and Prof. Loomis, for a distance of some three hundred miles from Cambridge to New York. In October last, it was repeated for a like number of stars between Philadelphia and Cincinnati, in connexion with Prof. Kendall and Prof. Mitchell, through a distance of seven hundred and fifty miles. The taps made on the telegraph key at the time of bisection at each place were registered at both. In these operations, however, the ear was used to estimate fractions of a second by the *audible* beats of the telegraph and observing clocks, and no use was made of the *visible* register.

"Dr. Locke's electro-magnetic clock of his own invention and construction (Wheatston's method not being known to him at the time) was used for some two hours or more, on the 17th of November last, to make the *automatic clock register* such as is described above. The distance tried was about four hundred miles from Cincinnati to Pittsburg.

"The experiment was completely successful. The interruption of the line from Pittsburg to Philadelphia that night prevented the actual continuation of the two operations on the same fillet of paper, namely, the graduation of the paper by the automatic clock, and the reciprocal imprinting of the dates of transits of stars at the two observatories. Each process, however, has been tried by itself to a sufficient extent by Mr. Walker and his associates, to warrant his conclusions with respect to their combination, for a more full trial of which he now waits for the construction of the most approved apparatus.

"In order to make the precision of the other appendages of a transit instrument commensurate with the *tenfold* increase of that of the art of imprinting the dates of bisections for a single culmination, Mr. Walker recommends the use of a cast-iron box for the frame.

"Each side should carry three or more levels.

"The number read on each occasion should depend upon the degree of precision aimed at. The instrument should admit of rapid reversal, even on equatoreal stars. For use at the station of the Coast Survey, Mr. Walker prefers to retain the micrometer adjustment of the azimuth, like that of the new Simms' transit instruments recently made for the survey.

"In the telegraph operations for longitude, two such transit instruments of moderate size are to be mounted, at any two stations, distant one or more thousand miles. All the levels are to be read with the instrument pointing to the zenith, then twenty bisections of a circum-zenith star, are to be imprinted on the *automatic clock register* previous to reversal. The like number for the same star on the same wires are to be imprinted after reversal, and the levels are again to be read.

"A similar operation is performed for the transit of the same star at the western station.

"The primitive astronomical clock may be located and rated at the central station of the Coast Survey. The *automatic clock register* may be made and kept there, even if the distance be a thousand miles from either station.

"Clock registers in any number may be made at the separate stations. The transits of two fundamental stars at remote dates, at either of the three stations, may give the rate of the primitive or central clock.

"One such transit of the same star over each station with twenty printed registers of normal bisections, and six normal levellings, with independent levels, at or near the position of actual observation, with the increased precision of the instrumental adjustments, will give in the form of a permanent printed record (with multiplied copies) the relative longitude of the two stations.

"The uncertainty of such a result need be only a few hundredths of a second, and may be such only as attends our present knowledge of the relative longitudes of Greenwich and Paris, the two oldest observatories extant.

"I avail myself of the occasion to remark, that the Coast Survey operations were completely successful this autumn between Philadelphia and Cincinnati, while actually working on the line from Philadelphia to Louisville. The distance of the line in the air is nine hundred miles, that of the circuit is eighteen hundred. I learn from an authentic source that the same success attends the use of the line from Philadelphia to the Mississippi river opposite St. Louis. The length of this circuit is *one-tenth* of the circumference of the earth. The inference from this trial is clear, that a line round the earth, if such could be constructed, might be worked with facility at one stroke. The expense of acids to supply the thousand Groves' pint cups, required for the motive power, would be about one pound sterling (five dollars) per day."

ERRATA.

At p. 61, paragraph 5, substitute as follows:—"General Hodgson was appointed Surveyor-General of India in May 1821, by Lord Hastings when Governor-General, but not confirmed by the Directors, who considered the patronage to be in their hands. In lieu of this, he was appointed Revenue Surveyor-General. In 1826, he was appointed Surveyor-General, and held that office till 1827, when grief for the loss of his beloved wife induced him to resign and to return to England."

P. 28, Liverpool Observations of Encke's Comet,
Oct. 10, *for* $15^h\ 15^m\ 59^s$ G.M.T., *read* $15^h\ 15^m\ 57^s$
$+36^s{\cdot}80$ Corr. Eph. $+36^s{\cdot}91$

P. 29 *et seq.*, Mr. Lassell's machine is a *polishing*, not a *grinding* machine.

P. 46, March 26, *for* 29^h, *read* 20^h.

P. 47, Dec. 21, 2d Observation, *for* $-0^s{\cdot}23$, *read* $-0^s{\cdot}83$
Dec. 23, 2d — $-1{\cdot}00$, $-1{\cdot}10$
Jan. 15, dele the first four lines which are repeated; towards the bottom, *for* five transits, *read* six.

P. 48, line 7, *for* six, *read* two; and *for* Jan. 11, *read* Jan. 15.

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